Rational use: the concealed energy source

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> Thankful for the beneficent milk that made him grow up strong, when Zeus was still a boy he presented the she-goat Almatéia with the cornucopia, which is the source of endless abundance. Since it can't rely on that gift, modern society must consider the energy question not only as a permanent and vain quest for resources to meet an insatiable demand, but from an integrated perspective of sources and uses, aiming reduce waste and value efficiency.

Foreword: the chain from sources to uses

One of the landmarks of the vertiginous technological evolution of modern society is the remarkable increase in energy demand, in all its forms, which determines a growing complexity of the energy systems, understood as the conversion and storage processes chain that link the natural resources to the final energy users. In the primitive societies the basic exogenous non-muscular energy source was mainly firewood, obtained near the place where it was used, occasionally complemented by wind or by the power of a waterfall. Nowadays, however, it is almost impossible for an energy user to have a clear knowledge of the origin and the processes undergone by the electricity used in his or her residence or the fuel that moves his or her car. Those are energy vectors produced in multiple sources that circulate through interconnected transportation systems, before finally being converted to useful heat, work and lighting, to mention just a few of the most significant energy uses.

Indeed, starting from the stocks and flows available in nature, energy goes through complex paths, undergoing successive transformations and storage processes, before becoming an actual well-being and economic development factor. As a consequence of that growing complexity, there was an increase of the energy losses, which constituted inevitable thermodynamic effects of the conversion and energy accumulation processes, in such a way that a proportionally ever decreasing portion of the energy obtained from nature carries out its role to the end users.

For a taxonomy of the energy losses

As the First Law of Thermodynamics postulates, energy is not destroyed, and it could seem vain to be worried about the energy losses, defined as the difference between the energy that an equipment consumes, such as electricity or diesel oil, and the resulting energy effect, such as the shining effect or the movement of a vehicle. However, even though energy always is actually conserved, in all the real energy processes there is an inevitable generation of entropy, which implies the progressive and inexorable destruction of the convertible energy reserves and the conversion of all energy forms into low temperature heat, which is almost useless for human needs. Indeed, the heat that the thermal power plants' condensers and the cooling towers of the air-conditioner systems rejects to the environment has almost no quality at all, in terms of the generation of energy sources more noble than heat. In this sense, the real indicators of the energy systems' efficiency and of the intensity of its losses are the entropy generation and its current engineering measure, the exergy balances, proposed by Rant back in 1956.

Classifying the energy losses can be interesting to discriminate the means to promote its reduction. A first criterion would be to separate the reversible losses, which derive from the heat-work transformations and vice-versa, from the irreversible ones, caused by real inefficiencies. For example, in the internal combustion engines, only about 30% of the chemical energy contained in the fuel is converted into useful effect, such as axis power. However, the heat that the exhaust pipes and the radiators of those machines expel into the environment can't be totally considered as waste, since the conversion of heat to work always takes place according to efficiencies that are limited in the top by the Second Law of Thermodynamics, which in the usual conditions of the real machines would be close to 50% (Bejan, 1988). In other words, the combustion engines are not as energy spendthrifts as they could seem, since only part of its losses is irreversible or irrecoverable.

In turn, in the electric engines, which convert electricity to axis power without the limitations of the thermal machines, all the energy losses observed are actually irreversible, and, in this case, provide the motto for two relevant energy loss categories, which are non-excludent and that occasionally must be tolerated: the technical and the economic losses.

The technical or technological losses exist as a result of the characteristics of the materials used (for example, the resistivity of the conductors), design constraints and thermal inertias, being therefore inevitable, within certain limits. In turn, and in a similar way, the economic losses are acceptable to the extent that its reduction would imply very heavy costs, conditioning the dimensions, the energy exchange rates and the duration of the real processes. Thus, moving away from the energetically ideal conceptions, subject only to the reversible losses, the real energy systems present tolerable irreversible losses due to technical and economic impositions, which must be kept at minimum levels.

Since the losses are intrinsic to the energy systems, it is interesting to classify the causes of the inefficiencies and avoidable energy losses that fall basically into three groups:

- Deficient project: due to the mistaken conception from the point of view of the design, of the materials, of the production process, the equipment and/or the systems lead to energy wastes, for example, by using inefficient lamps or by arranging them incorrectly according to the principles of rational energy use;
- Inefficient operation: even when the energy systems are well conceived, they can be operated in an irresponsible manner, for example, keeping a room without any activity with efficient lamps turned on unnecessarily;
- Inadequate maintenance: part of the losses and of the energy wastes could be minimized through adequate procedures of both corrective and preventive maintenance, which include the correct adjustment and control of the systems, so that they are able to keep, as far as possible, the performance of the original conditions.

The performance improvement measures must consider the different intervention levels, especially those related to the causes mentioned above and, as far as possible, articulate actions that combine and potentialize the results towards energy efficiency. For example, the diffusion of more efficient equipment doesn't exclude recommending its use in a more efficient manner. The adoption of a compact fluorescent lamp replacing an incandescent lamp, kept turned on in a place where there is enough natural light available, obviously doesn't mean energy saving. Under those concepts, we can classify the mechanisms to encourage energy efficiency within two broad categories:

1. Technology-based mechanisms: involve the implementation of new processes and the use of new equipment that permit reducing energy losses;
2. Behavior-based mechanisms: are based on habit changes and utilization patterns, reducing energy consumption without altering the energy equipment or appliance.

That classification is important above all because the changes in process or equipment require much more significant investments than the habit changes and the utilization patterns. Besides, in general, a reasonable potential for energy saving can be expected related only to the behavior changes of the consumers, especially in the residential sector, but also in a relevant manner for the other sectors, allowing to get typically between 15% and 30% of energy savings only due to changing habits, such as the rate of use of electric irons and washing machines, as well as the setting of refrigerator and air-conditioner thermostats, the attention to the unnecessary use of electric lighting, etc. (PROCEL, 2006a). It is important to note that all the measures to reduce the energy losses don't affect the benefits that derive from the energy use, since energy for final use is kept. Using energy well is not stinginess, but above all increasing its rationality and productivity, creating “virtual electricity plants”, which are economically competitive and absolutely non-pollutant.

A little more complex and a growing object of studies are the energy losses that derive from a comprehensive view of the energy systems in time and space, which is the theme of the so-called “life-cycle analyses”. By extrapolating the boundaries of the energy equipment and considering all the inputs and energy effects along its production, operation and final arrangement, it becomes possible to extend the loss concepts and to determine in an almost complete manner the energy performance of a system. For example, an efficient lamp can consume a lot of energy in its process of production and rejection in the end of its useful life, occasionally neutralizing the energy benefits that derive from its operation. Despite the undeniable importance of that approach, it is still essential to reinforce the information base about energy costs in this sense before accomplishing its greater use as an energy policy tool.

The evolution of the institutional landmark

The awareness that the demand management and the promotion of the rational use can be considered as an energy resource has justified governmental measures in several countries, especially in the most developed ones, where during the last decades they have acted systematically and intensely to improve energy efficiency. In those contexts, besides the economic advantages related to the increase in energy productivity, the environmental benefits that derive from the lower energy consumption have been encouraging, both locally and globally. Some important governmental action references include such entities as the Canadian Office of Energy Efficiency (OEE), the French Agence de l’Environnement et de la Maîtrise de l’Energie (Ademe), and the British Energy Saving Trust (EST), with a long and expressive list of services rendered to their respective societies. The programs developed value the marketing activities, aiming at increasing the awareness of people regarding the advantages of the efficient energy use, the establishment of rules and the concession of financial incentives for products, equipment and services that make improvements in energy efficiency possible, including almost all consumption sectors.

In Brazil, since the oil shocks of the 1970’s, the government has adopted, especially in times of crises, actions and programs aiming at the reduction of energy losses. Created in 1981 by the federal government, the “Conserve” Program was the first solid effort to promote energy efficiency in the industry, especially considering the oil by-products and encouraging the substitution of important energy sources. At that time there was the emergence of the practice to undertake energy diagnosis in industrial and commercial businesses to identify the reduction potential of the energy losses in each case. In 1984, the actions of the Brazilian Labeling Program (PBE) began, coordinated by the National Institute of Metrology, Standardization and Industrial Quality (INMETRO), which is directed towards the performance evaluation of energy equipment and information to the consumers, labeling a wide range of equipment models that include appliances, electric engines, stoves and gas-fired water heaters, as well as solar collectors. Such process for evaluating the conformity requires the establishment of standardized test procedures, the implantation of performance measurement laboratories and is developed in strict articulation and cooperation with both the producers and suppliers.

Later, after the oil crisis was overcome, the conjuncture of the electric sector was aggravated, leading to the creation, in 1985, of the National Electricity Conservation Program (PROCEL), coordinated by ELETROBRÁS. That program is made up of several subprograms, with actions in the industrial, sanitation, education, edification, public buildings, municipal energy management, information, technological development and diffusion areas, with a rich background of experiences and effective results (PROCEL, 2006b). Special attention is given to the PROCEL Label and Award which, along with the labeling and marketing activities, are responsible for almost 70% of the results obtained. As a complement and guided by the National Electricity Agency ANEEL), since 1999 the Program for Energy Efficiency (PEE) has directed the application of 0.5% of the electricity concessionaries' earnings to energy efficiency, relying on a significant budget.

With the acknowledgement of analogous potentials for energy savings in the fuel sector, the National Program for the Rationalization of the Use of Petroleum By-Products and of Natural Gas (CONPET) is managed by PETROBRAS, in which actions in the fields of cargo, passenger and fuel transportation, as well as educational, marketing and labeling actions stand out, such as the CONPET Label and Award.

Those programs have accumulated several results, even though they still can't rely on the adequate visibility and the deserved importance level, besides a lack of coordination among them. Still in the federal level, an important landmark for energy efficiency in Brazil was Law n. 10, 295, approved in October 2001, which dealt with the National Policy for the Conservation and the Rational Use of Energy. That law predicts the establishment of "maximum levels of specific energy consumption, or minimum levels of energy efficiency, of machines and energy-consuming devices produced and sold in Brazil", which is under the responsibility of the Management Committee of Indicators and of Energy Efficiency (CGIEE), constituted according to Decree n. 4.059, also from 2001. That legislation was discussed for a long time and represents an institutional maturation in the promotion of energy efficiency in Brazil that must be preserved and valued. By means of its instruments, minimum performance levels for three-phase induction electric engines, as well as for compact fluorescent lamps were defined. Refrigerators, air-conditioners, stoves and gas heaters are in an advanced regulation stage. It is interesting to observe that this law allows us to define minimum performance levels that are compulsory in nature. Therefore, it is different from the labeling that classifies the efficiency of PBE, which is essentially voluntary.

Perspectives on energy efficiency: a few examples

To exemplify the possibilities to reduce the energy wasting, next is commented on the potentialities of rational use of energy of some equipment and final uses representative of the Brazilian energy context, introducing cases in which solutions were succeed and others in which measures to reduce the losses have not been taken yet. The selected cases to comment are the domestic refrigeration equipment, the electric showers, the light vehicles and co-generation. Those cases don't include the entire range of equipment and consumption sectors; however, it can be stated that in all others similar perspectives can be observed, in which there is the conjugation of technological developments and the introduction of more responsible habits in the use of energy.

Domestic refrigeration

The equipment for refrigeration of food and beverages are among the greatest energy consumers in the residential sector in Brazil, accounting for 28% of the consumption of that sector. Its efficiency has an important effect on the electricity consumption. Acknowledging that framework, since 1995 is used the PROCEL Label, which rank the best products and guide the consumers when they buy refrigerators and freezers. As a result of that Program, there has been a remarkable evolution of the efficiency, exemplified by a 20% reduction in energy consumption, which fell from 400 to 320 kWh/year between 1995 and 2005, in the case of the single-door refrigerators (PROCEL, 2006c). The main measures adopted were the improvement of the compressors, the increase of the thickness of the thermal isolation and the improvements in the sealing and in the control system.

Aiming to evaluate the energy effects of the PROCEL Label in such appliances, the energy consumption throughout their useful life was estimated for equipments with and without the Label. Thus it was possible to determine the energy savings actually reached due to the partial adoption of the labeled equipment by the market and the total potential saving, which corresponds to the full adoption of the labeled equipment (PROCEL, 2006c). In that study the effect of the equipment's age and of outside temperature on its performance were considered. Such factors interfere significantly on the energy consumption. For that reason, it was necessary to separate the equipment by categories, to estimate the existing parks in the several years and to work regionally to consistently evaluate the energy saving. The preliminary results of that study, which is in its conclusion stage by PROCEL, are shown in Figure 1 considering all the refrigerators and freezers existent in Brazil. The upper red line shows what would be the consumption if the equipment had the average efficiency without Label.; the green line shows the estimated consumption with the current level of adoption of the Label (almost 50% of all refrigerators and freezers) and the blue line shows the consumption that would result if there was full adoption (100%) by the market of Labeled equipment.

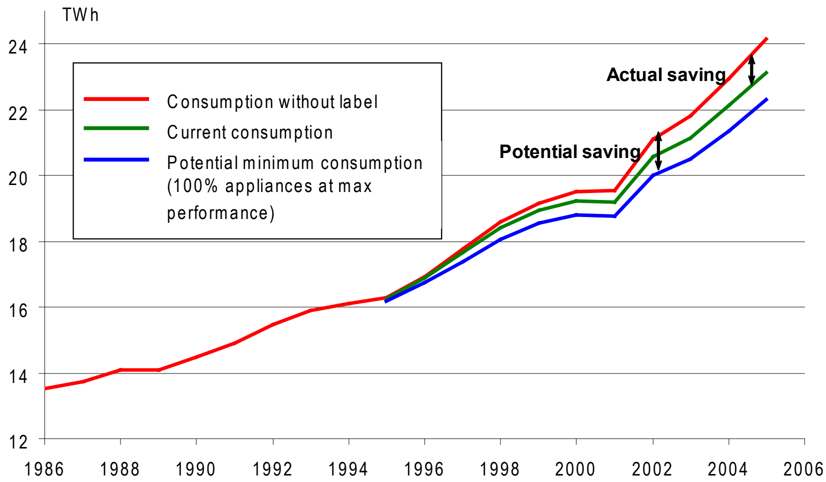

Figure 1 – Electricity consumption in refrigerators and freezers in Brazil and the effect of the Procel Label (preliminary figures, PROCEL 2006c).

According to the evaluation made, in 2004 the refrigerators and freezers existent in Brazil consumed 22,136 GWh, which meant a 3,5% saving (806 GWh) compared to the consumption that would be observed if the Label was not adopted in its current levels, which was estimated at 22,942 GWh. The total saving potential, correspondent to the full adoption of the Label, is estimated at 6.9% (1,580 GWh). Considering the impact on the power needs, in 2005 the (PROCEL, 2006c) Label contributed for the reduction of power demand of almost 150 MW, for refrigerators and freezers alone, which is equivalent to a greater power than the installed capacity at Funil Hydro Power Plant, in Itatiaia, RJ (PROCEL, 2006c).

Residential water heating

The electric shower, which is responsible for almost 26% of the electricity consumed in the Brazilian households, is a patent of the 1950's, when begun the expansion of Brazilian electric grid and increased of the urbanization rate, outspreading especially in the South and Southeast regions and permitting the healthy Indian habit of the daily bath to get consolidated among us. Despite those merits, the electric shower has serious disadvantages. Indeed, it is possible to state that it is actually a paradigm of inefficiency and of the absence of rationality in the use of energy.

First of all, the electric shower is a passage heater. In other words, it heats water at the time of use. For that reason it requires high power, mainly when the water flow and the temperature difference desired are high. Therefore, showers represent not only the greatest energy consumers in the households (in kWh), but they also define the power required in the households (in kW), with a direct impact on the supply conditions by the concessionaries, even because baths often taken during the period of day near the top of load curve. When the economic effects are compared, such power concentration becomes even more serious: a small electric douche consumes almost 4 kW, costs less than 20 reais, but it requires an power availability that, with an implantation cost of almost 2,500 dollars per installed kW (generation, transmission, distribution) and a 50% coincidence factor, generates a burden to society of at least 10,000 reais. That is basically why the electric shower almost doesn't exist in other countries, in which typically fuels are used to heat water and when electric heating is used accumulation heaters are used, with very limited allowed installed capacity.

The second great problem of showers is their extremely low efficiency in energy conversion. Electricity is a noble form of energy and when it is converted into low temperature heat it generates a great irreversible loss, which may be evaluated by the significant entropy generation that it promotes. A typical electric shower uses less than 5% of the energy availability that it consumes and wastes the rest. While electricity produced in hydroelectric power plants is used this problem is only serious, but when is put forward plans to increase the share of thermal generation, we have a huge nonsense: to burn a fuel to obtain heat, to produce electricity, to obtain heat once again means multiplying energy wasting by three.

Naturally the large number of electric showers that exist today will continue to operate for quite some time, but despite any energy crisis, it is crucial to seek the gradual introduction of more sensible technologies. Water heating directly from thermal sources is undoubtedly better. In the same way the use of heat pumps, still scarcely known in Brazil, must be promoted. They permit great loss reduction compared to showers. With a heat pump, a certain amount of electricity promotes a thermal effect six to eight times greater than the one obtained by the electric shower. For that reason, the recent and irresponsible government measures that reduced the federal taxes on electric showers are regrettable. They are moving in the opposite direction to energy rationality, disencouraging the adoption of solar collectors and the use of such fuels as LPG and natural gas.

Cars (light automotive vehicles)

Understandable due to the continental dimensions of its territory, the main use of fuels in Brazil is related to the movement of goods and people, accounting for 34% of energy consumption in Brazil in 2005, except for electricity (MME, 2006a). As far as the fuels consumption are concerned, more than half is consumed in combustion engines, mostly in light vehicles and trucks. In fact, the highway sector represents 92% of the total fuel consumption in the transportation sector, due to the limitations of the railway network and to the infrastructure for other modals. As far as the diversity of fuels used is concerned, the Brazilian market for automotive fuels is one of the most dynamic in the world. Throughout the last few decades it was possible to observe the introduction of the biofuels in a significant manner and the quick adoption of automotive natural gas.

As far as the great importance of the energy demand related to cargo and passenger transportation, associated to trucks and buses, the consumers of light vehicles, approximately 20 million cars, have limited access to the data concerning their vehicles' efficiency. For the commercial vehicles, on the contrary, those data are relevant and well-known, even because they have a strong influence in the constitution of the operational costs. Much of the specialized press seems to ignore the energy performance, giving value only to the aesthetic aspects, as well as comfort and power.

With the evolution of the automotive market, the power of the vehicles has been increasing significantly, occasionally above the needs and not paying much attention to the specific consumption, which indicates a clear margin for improvement. As a consequence of the greater importance given to the rational energy use in many countries, the improvement of the energy performance figures is remarkable, even when modern cars include items that involve greater energy consumption, such as air-conditioning systems and power steering. The full disclosure of energy efficiency rates and the definition of performance goals in vehicles have been leading to significant results in several countries, with benefits not only in terms of energy saving and the reduction of air pollution, but also in terms of income generation and the increase of job opportunities (Bezdek & Wendling, 2005).

As an indicator of the apparent potential for energy saving in Brazilian cars, Figure 2 shows how the average specific consumptions in the Brazilian cars that run on gasoline and on alcohol grew respectively 13% and 35% in the last twenty years (Branco et al., 2004). The red columns in this chart refer to the equivalent energy consumption in pure gasoline, without 22% ethanol, the reference fuel blend used for Brazilian automakers. With the emergence of the flexible fuel engines, the necessity to promote vehicle efficiency becomes even clearer, since those engines could be the most efficient when using gasoline and they are the least efficient when using alcohol (IMT, 2004).

That situation tends to change in the desirable direction in Brazil. The result of a convenient agreement involving governmental entities and the automotive industry, by means of the National Association of Automotive Vehicle Manufacturers (ANFAVEA), in an effort lead by CONPET and

INMETRO within the scope of the Management Committee of Energy Efficiency of MME, the decision was made to adopt energy efficiency labels in light vehicles produced in Brazil. This is an extremely important advancement to supply the consumers with more information about the performance of their cars, which may progressively become a decisive aspect among their characteristics. It is worth commenting that in many countries the energy efficiency labeling (and consequently, that of emissions) is a normal practice; however, its adoption imposed the previous establishment of test procedures, classification of both the vehicles and the performance groups (CONPET, 2005).

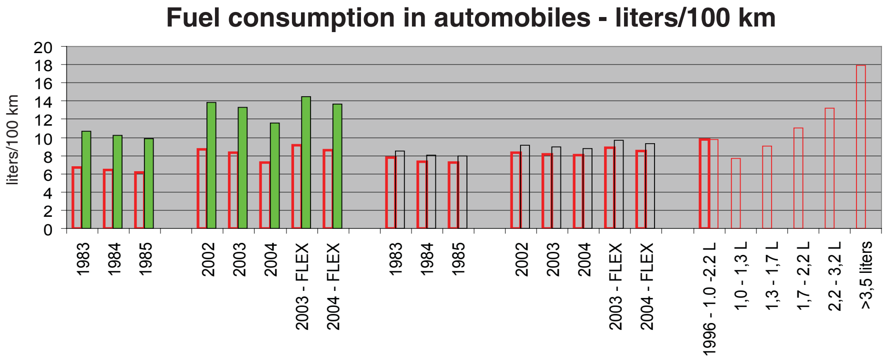

Figure 2. Average consumptions in light vehicles in Brazil (Branco et al., 2004).

Co-generation

Co-generation is perhaps one of the most emblematic examples of the ignored potential of the efficient use of the energy resources, unnoticed by most fuel consumers in heaters, ovens and boilers. In fact, when the simple energy balances are used to evaluate the performance of those thermal equipment, it is common to establish relatively high efficiency rates, about 80%. For that reason it seems that the energy losses, observed mainly as hot flue gases in the chimneys, represent a small and almost inevitable part related to the combustion and heat transferring processes. However, a more careful analysis and using the thermodynamic principles in a correct manner, shows that when a fuel is used, generally are produced flame temperatures higher than 1,200°C, to meet thermal demands typically at temperatures lower than 200°C, meaning that an important capacity to produce useful power is lost. The most correct form to use the fuel energy in that case is through a thermal cycle, with an engine or a turbine generating power and rejecting heat in the desired temperature level, with lower entropy generation.

As an excellent example of the co-generation use, sugar and ethanol mills burn the sugar cane bagasse in boilers, generating high pressure steam, which expands in turbines until the pressure that is required in the industrial process, generating a considerable amount of electricity. When using steam boiler pressures of approximately 20 bar, the mills reach electrical self-sufficiency; however, as the steam enthalpy increases, the thermodynamic losses are reduced and the generation of electricity surplus increases in the same proportion. For pressures of 60 bar and temperatures of 450°C in the exit of the boilers, a surplus of approximately 60 kWh per ton of processed sugar cane may be produced, almost without increasing the fuel waste. Several other sectors that associate electric and thermal loads (including low temperature ones), such as the chemical, textile and food industries as well as shopping malls, airports, hotels and hospitals, may adopt co-generation with positive results (Silva & Haddad, 2006).

In several industrialized countries the technology for the combined generation of electricity and useful heat has been encouraged, aiming at environmental and economic benefits, with significant results in terms of the reduction in the costs of the expansion of the generation capacity. Globally, the installed power in co-generation systems has expanded in a rate higher than 7% per year, and in the American case alone, using mainly natural gas, co-generation has aggregated almost 70 GW (WADE, 2006) in the last fifteen years, which is almost the total capacity currently installed in the Brazilian hydroelectric power plants.

The capacity of the co-generation systems in Brazil is expected to reach 1.4 GW (nominal capacity of the plants qualified by ANEEL, 2006); however, there is still great potential waiting to be developed. According to estimates, in the sugar and alcohol and in the paper and pulp sectors alone co-generation could reach respectively 4.0 GW and 1.7 GW, with conventional technologies (WADE, 2006), broadening the reliability, postponing generation investments in the electric system and improving the energy efficiency in Brazil. The main obstacles that must be overcome to expand co-generation in Brazil are the persistence of a shy regulatory landmark to encourage self-producers and setting the appropriate conditions for interconnected operation and the transaction of energy surplus, as well as the limited natural gas distribution network.

Potentials for rational energy use in Brazil

The preliminary studies about the potential resulting from the increase of the energy efficiency in Brazil, undertaken within the scope of the National Energy Plan, which forecasts energy scenarios to 2030, indicate significant figures, as shown in the figures below (MME, 2006b). For electricity, the figures presented are based on estimates made by the Brazilian Association of Energy Services Companies (Abesco) and by ELETROBRÁS (Reluz Project), indicating a total saving potential of 29.7 TWh (terawatts per hour), approximately 8.3% of the consumption observed in 2005. Considering a value of R$ 130,00 per MWh, the implementation of these efficiency measures in the electric systems could represent as much as R$ 3.86 billion per year in savings. For sectors that use oil and natural gas by-products, the increase of the energy rationality would reach 5.5 million TOE (tons of oil equivalent) or, in other words, 6.7% of the national oil consumption. Taking for granted an average price for these fuels of US$ 65,00 per barrel and an exchange rate of 2,00 reais per dollar, the elimination of that waste would permit an annual saving of 5.2 billion reais.

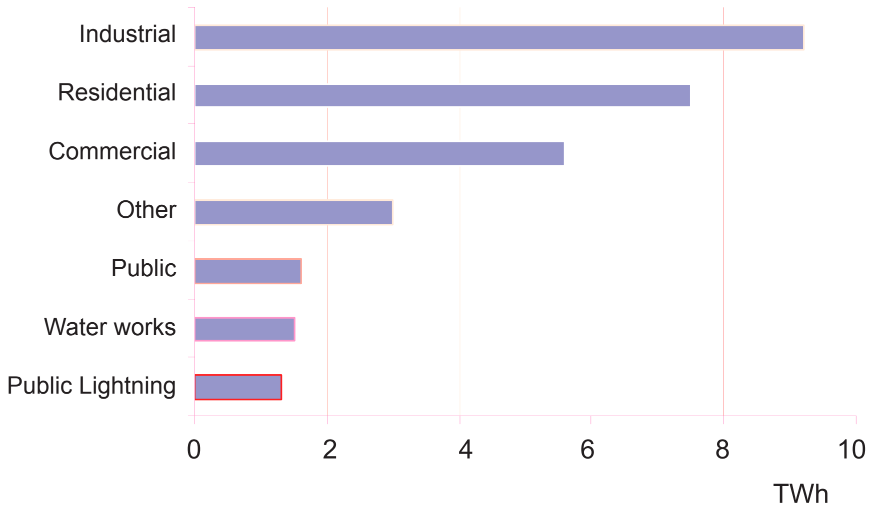

Figure 3 – Brazilian potential for electricity saving (MME, 2006b).

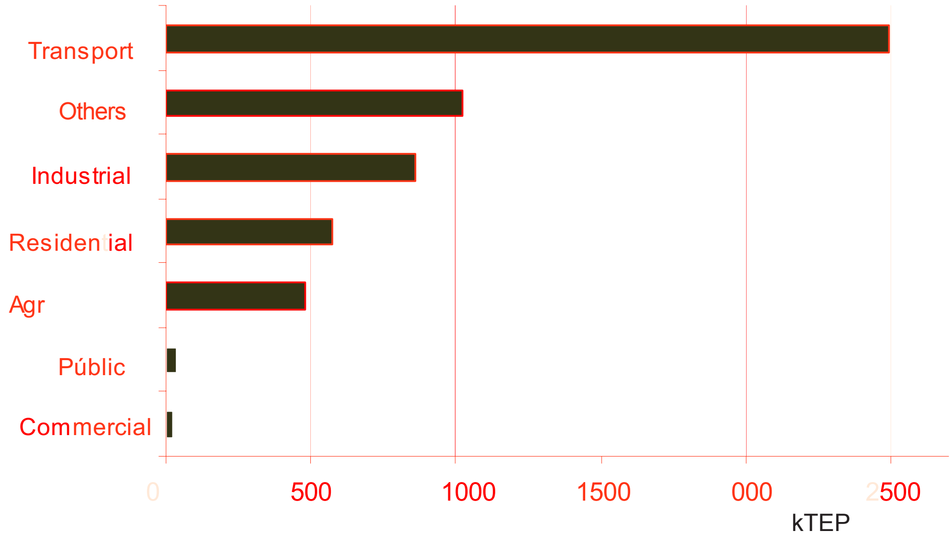

Figure 4 – Brazilian potential for oil and natural gas by-products saving (MME, 2006b).

Such potentials are preliminary estimates and the expectation is that as its development is promoted the actual figures become known in a more consistent manner, as well as other potentials may be discriminated. In that sense, quantitative and whenever possible auditable evaluation of the results of energy efficiency programs is extremely relevant. The main obstacle is to make a good estimate of the energy consumption that won't take place and the saved power, but some methodologies have been developed. The current efforts to consolidate an international methodology for the monitoring and evaluation of the results of the energy efficiency programs, through the International Performance Measurement and Verification Protocol (IPMVP), must be mentioned. The Program for the Evaluation of the Measures for Energy Efficiency and Demand Management developed by the International Energy Agency and with case studies in Belgium, Canada, South Korea, Denmark, France, Holland, Italy and Sweden, proposed a detailed and comprehensive review of such methodologies. As a general rule, this reference recommends the comparison of the charge curves before and after the adoption of the measures for the encouragement of efficiency, thus comparing the baselines to the modified charge curves (IEA/DSM, 2006), as was previously presented for the evaluation of the impact of the PROCEL Label on the consumption of refrigerators and freezers.

Above and beyond the technological evolution as a source of alternatives for the reduction of the energy wastes, the significance of diffusing more responsible uses and habits must be reiterated. Simple awareness measures may lead to significant savings of both fuel and electricity, due only to the loss reduction and without affecting the services supplied by the energy.

Conclusions

The limited consciousness of significant energy potential related to increasing efficiency and the persistence of a fractioned and reductionist approach of energy systems just from the perspectives of primary sources have defined and maintained an high level of energy losses in actual systems, basically due to the absence of integration between uses and proper matching of the energy flows, connecting sources and users. Indeed, and only as an example, the electric sector, which recently began to become increasingly worried about unbalance between the electricity availability and its demand, has offered in general as solution only the obsessive increase of the installed capacity, under economically and environmentally questionable conditions, without paying due attention to the demand management, which is considered on a superficial and secondary manner. International studies have shown that each dollar invested in energy efficiency saves two dollars in energy generation and distribution systems (IEA, 2006). In that sense one must consider as a remarkable advance the new perspectives for the insertion of efficiency in the agenda of the energy authorities, which will have the possibility to leave the immobility of recent years behind and resume programs and actions for the encouragement of the energy rationality with the necessary intensity.

The landmarks of energy policy must be reviewed, especially concerning its subordination to the guidelines of the supply agents, who are unable to see beyond the energy billing instruments, be them devices to measure watts per hour or fuel pumps, and resume the goals of sound energy development, in which energy is a means and not an end within itself.

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Abstract – Modern energy systems are complex exploitation networks of natural resources with successive conversion and energy transportation processes and a high level of losses. These losses constitutue a virtual energy source that must be better exploited in order to provide economic and environmental advantadges. Here, the concept of energy system loss and the evolution of Brazilian institutional framework to enhance the promotion of a rational use of energy will be presented, as well as the perspectives to reduce energy waste in end uses: domestic refrigeration, residential water heat, light vehicles and co-generation. The estimated total capacities of electric energy and fuel economy (by consuming sectors) are also presented.

Keywords: Energy conservation, Energy uses, Energy efficiency, Rational use of energy.

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